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ANALYSIS OF BODY MASS INDEX AND FIRST-TERM ATTRITION OF NAVY ENLISTED PERSONNEL

by

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June 2017

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ABSTRACT

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LIST OF ACRONYMS AND ABBREVIATIONS

AFQT	Armed Forces Qualification Test
BCA	Body Composition Assessment
BMI	Body Mass Index
BUMED	U.S. Navy Bureau of Medicine and Surgery
CTT	Cryptographic Technician (Technical)
CNRC	Commander, Navy Recruiting Command
DEP	Delayed Entry Program
DMDC	Defense Manpower Data Center
DOD	Department of Defense
FY	Fiscal Year
GAO	Government Accountability Office
GED	General Educational Development
HT	Hull Maintenance Technician
IC	Interior Communications Electrician
IT	Information Systems Technician
MEPCOM	Military Entrance Processing Command
MEPS	Military Entrance Processing Station
MOS	Military Occupation Specialty
NCB	Non-Compliant Boarding
PRIDE	Personalized Recruiting for Immediate and Delayed Enlistment
PT	Physical Training
SRF-A	Security Reaction Force-Advanced
SRF-B	Security Reaction Force-Basic
STG	Sonar Technician (Surface)
VBSS	Visit, Board, Search, and Seizure
WHR	Waist-to-Hip Ratio

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I. INTRODUCTION

It is a stark reality that most young Americans aged 17 to 24 years are not sufficiently physically fit to join the military. The 17–24 age group comprises the largest portion of potential enlistees. This group and other age groups have apparently become susceptible to a lifestyle that renders approximately 71 percent unqualified due to health and physical appearance issues (Feeney, 2014).

One study reports that, within the last few years, over one-third of the United States (U.S.) adult population is considered obese, and the greatest prevalence of obesity in recent history was from 2009–2010 (Flegal, Carroll, Kit, & Ogden, 2012). Young men and women may still able to enlist into the Navy even if they do not meet the BMI standards. A medical waiver can be requested, and it is likely that these individuals expect that the initial training (boot camp) received or intermediate time while awaiting initial training will help them meet the standard at some point. Intermediate training commands often hold overweight sailors in training status to improve physical fitness.

Those individuals who are able to join the military still may be unable to fulfill their initial service obligation through failure to meet and maintain physical standards. The Navy separates sailors from service only after multiple violations of the body mass index standard. Whether sailors are underweight or overweight can significantly impact their work performance. Besides certain Navy occupations that require constant physical standards to be maintained throughout the year, no systematic method exists to ensure that sailors are physically ready to pass the semi-annual body composition assessment (BCA). The Navy seeks to help sailors who are above or below height/weight standards prior to the semi-annual BCA through physical fitness programs and nutrition classes. These measures, however, while available, are not a requirement, nor are they tailored to allow sailors to perform their occupations specifically (Navy Fitness, 2015). Anecdotal evidence suggests that sailors engage in a variety of methods, including over exercise, crash-diets, and other techniques to meet the appropriate BCA benchmark. These methods are not sustainable and, in some cases, are harmful to the sailor in question.

Studies have shown that maintaining a healthy lifestyle can help stress levels at work, as stress can induce weight loss in lean individuals and weight gain in overweight individuals (Kivimaki et al., 2006). Stress is a factor in how well personnel perform their duties, regardless of the mission. Navy-sponsored resources like physical fitness programs and nutrition classes can help sailors maintain a healthy lifestyle and encourage reducing stress, which can lead to greater accomplishment at work. Tucker, Cole, and Friedman (1986) assessed more than 4,000 civilian adult males and determined the extent to which physically fit and unfit males differ in regard to stress in their lives. Their study showed that unfit participants exhibited significant levels of stress. Even though the sample consisted of civilian males, it is likely that a similar correlation exists between stress and fitness among military personnel. Regardless of how fit or unfit a sailor is, the variety of Navy occupations all lend themselves to some level of stress that is often unavoidable; occupational stress is only exacerbated by poor health. As U.S. society becomes more reliant on technology, less emphasis is placed on physical activity in the workplace, but the need for workers who are physically fit continues. This lack of attention to physical activity is one of the factors responsible for the obesity epidemic (Gutierrez-Fisac & Guallar-Castillon, 2002).

A difference exists between what U.S. Navy Bureau of Medicine and Surgery (BUMED) and what civilian medical practitioners define as an individual within acceptable physical health. This difference is more restrictive for BUMED. For example, a male with a BMI of 28 would be within acceptable physical health under the nationwide standard ("Calculate Your BMI," 2014). Under the BUMED standard, however, this male would not be within acceptable physical health because a BMI of 26 is the upper limit for males (Navy Fitness, 2015). This male sailor could see his civilian physician and leave with an assessment that he is ready to enlist and would meet the physical health requirement strictly based on height and weight. This same individual would then fail to be within the BUMED physical standard, and would likely need to obtain a medical waiver to enlist or spend time prior to accession reducing BMI to an appropriate number.

Similarly, another difference exists between what is considered “overweight” for a male. While Navy applicants do have cause for concern when not meeting these standards because they are either overweight or underweight, attention typically centers on those who are overweight and are not able to maintain a “healthy weight.” These potential recruits face the toughest challenge of being able to uphold their contracted obligation even after entering into the Navy (Cawley & Maclean, 2011).

Adequately managing physical standards of Navy personnel is paramount to ensure sailors are strong, fit, and mentally sound to perform their assigned duties at optimal levels. It can be broken down into two functional steps that Naghii (2006) notes to foster in the best results for a healthy military lifestyle. The first step in proper management is assessing where the sailor stands in terms of performance ability. In many cases, body weight and height measurements should be taken and the individual’s BMI calculated. Should the BMI for this individual be within a healthy range, extra measurements would not be needed. A BMI consistent with being overweight does not, by itself, indicate that an individual is unhealthy and has excess body fat. Additional testing would be the next course of action to determine whether the excess weight consists of fat or lean mass. This testing would alleviate the burden of the individuals having to work harder than necessary to alter their lifestyle because of an incorrect body assessment. The additional testing would be important because research has linked higher BMI to injury rates in initial military entry training where many days can be lost and millions of dollars spent on medical care for injured personnel (Naghii, 2006). Having these sailors properly assessed would let training instructors know who might be at risk for injury and who is more likely to fare better in training.

The second step in proper management is creating an effective way to prevent future weight issues from occurring. This step starts with the first days of boot camp training and advanced in-rate training to ensure a healthy weight is being maintained or a healthy weight loss is occurring, to inhibit sailors from losing weight only to gain it back. This training helps sailors reach a healthy BMI and make it possible to handle certain tasks that they are assigned to perform. While many factors are responsible for first-term attrition within the Navy, physical job performance and weight control are either unnoticed or not appropriately assessed across the entire Navy fleet (Wenger & Hodari, 2004; Buddin, 2005). More attention needs to be paid to the regulation of our sailors' physical performance so we can continue to keep the best sailors and aid others to become better sailors.

This thesis examines Navy first-term enlisted attrition rates from fiscal years 2001 to 2009. The analysis provides valuable information regarding how body mass and other factors influence the likelihood of attrition, and gives insight as to how body mass can be adequately measured to determine first-term success better at the time of accession. This thesis concludes that, while controlling for other factors, a high BMI increases first-term attrition.

A. BACKGROUND

Within the last few years, for example, a growing mission area has been Visit, Board, Search, and Seizure (VBSS). VBSS focuses on the training of volunteers who are physically fit and are suitable for VBSS missions. These sailors perform functions such as boarding other naval vessels and securing the vessel from potential enemy threats and sanction violations. VBSS team members must also be well-trained swimmers and be able to perform their duties wearing the additional VBSS equipment. The VBSS mission, however, is a supplementary duty and places additional work and fitness requirements on the individual sailor.

Given ancillary missions such as VBSS, the pool of potential volunteers is often small due to the lack of physical fitness among the general population of sailors (Rank, 2012). These sailors performing two primary functions onboard their ships experience inherently more stress. The VBSS mission is still in its infancy, but continues to be a growing mission area that will require a greater applicant pool, as the certification and deployment of these VBSS teams continues to progress. Providing a ship with more capable sailors entering the training pipeline earlier in their term will extend the time and personnel resources available for an operational command to perform this mission area.

One reason these ships default to relying on only a select few sailors to make up these teams is because resources and training are only invested in those who already meet the physical standard when reporting to a ship. Even if sailors desired to be part of a VBSS or similar team, a lack of the requisite physical qualifications would preclude them from participation. No option exists to prepare these sailors for supplementary duty because, typically, the only existing training is targeted to physically fit sailors only. The Navy should invest in those aspiring sailors who have the desire to push themselves. Fostering a community in which it is easy and feasible for sailors to achieve more than just their primary Navy occupation should allow more overall job satisfaction, while potentially reducing work stress as a whole. Individual achievement is marginal without the adequate resources accessible.

This impact of only having a handful of sailors perform maximum work is not only felt onboard ship, but throughout the Navy. The following quoted analysis published by the Naval Health Research Center talks to this point of how recruiting and training inadequate sailors can have dire effects on those few well-equipped to work onboard ships. This analysis comes from previous U.S. Government Accountability Office (GAO) reports:

> After the publication of the 1997 and 1998 GAO reports, attrition increased still further and has recently stood at historically high levels. In addition to the growing financial impact of increased attrition, early personnel losses place an increased work load and strain on the remaining staff, harming morale and readiness. Thus, the negative effects of attrition ripple throughout the armed forces, especially in times of high operational tempo. Also, because attrition creates a need for replacement personnel, it exacerbates demands on recruiters who already face difficult recruiting goals… The GAO estimated that in fiscal year 1996 alone, the services lost an investment of $390 million by recruiting and training enlistees who separated before they had completed 6 months of service. (Booth-Kewley, Larson, & Ryan, 2002)

While this GAO report is dated from the late 1990s, the implementation of monetary application still holds valid. The money used to recruit and train new sailors who do not make it through their first year of service can be better spent on equipping sailors currently in the Navy should higher standards of the personnel selection process be in place. If recruiting standards were higher in terms of the quality of sailors recruited, separations would likely be lower, and the previously lost monetary accession resources could be reinvested elsewhere. Looking proactively to resolve monetary constraints, along with issues like stress and a lack of work productivity, can benefit the naval organization and sailors' workplace.

Work stress continues to be a prevalent concern among those in the civilian work force and the military. One factor contributing to stress is the level of obesity that is widespread in various facets of occupations that can negatively impact productivity. Bernaards, Proper, and Hildebrandt (2007) report that obese male computer workers showed significantly lower productivity than lean or merely overweight computer workers. Working while being obese can lead to increased weight gain, unhealthy weight loss, work stress, and decreased cognitive function, among other issues (Gunstad, Lhotsky, Wendell, Ferrucci, & Zonderman, 2010). Operating technical equipment routinely, spending countless hours awake standing watch, and conducting various shipboard evolutions demands a special type of physical and mental performance from any sailor. Sailors with excessive weight can not only harm themselves, but other sailors at that command can suffer detrimental consequences.

While the Navy has not recently struggled in terms of meeting its recruiting benchmarks, attrition remains a concern. According to the Congressional Research Service, first-term attrition rates hover around 30–35 percent (Kapp, 2013). This thesis will examine recruits from all character facets, among which are high-quality recruits. High-quality recruits are defined as sailors who have a high Armed Forces qualification test (AFQT) score, which is taken as a prerequisite to entering the military, and some college or higher education degree. Since some sailors enter the Navy with a high AFQT score, excelled in academics prior to entry, and typically perform well in their occupational rating, it is likely that these sailors would also place an emphasis on maintaining a healthy BMI. A correlation could thus be drawn between healthy BMI and lower attrition rates (Buddin, 2005). It would be of interest to see if such a relationship exists because recruiters could target potential sailors with high AFQT scores among other factors to have a greater likelihood of retention success and a lower rate of attrition.

This thesis examines the relationship between a sailor's BMI and the likelihood of attrition. The importance behind this study is empirically to determine whether BMI affects attrition for Navy sailors. Contributing factors like the comparison between civilian and military physical standards can show potential benefits from a corrected method of measurement and can ensure sailors are not separating due to skewed standards.

B. OBJECTIVES

The objectives of this thesis are to: (1) examine the influence of BMI on first-term attrition for enlisted sailors; and (2) examine the Navy's BMI standard. While there are numerous factors that may influence first-term attrition, this study focuses on BMI, demographic, and education characteristics. Holding other factors constant, this thesis attempts to quantify the impact of BMI on attrition likelihood.

1. Primary Research Questions

- Do Navy recruits' BMI at time of entry correlate to their likelihood of first-term attrition?
- Controlling for individual characteristics and demographic factors, does BMI at time of accession to service affect the likelihood of first-term attrition?
- If BMI is shown to predict attrition, what are the possible causes?

2. Secondary Research Questions

- What are the Navy's enlistment standards for BMI, and have these changed over time?
- Should enlistment standards, occupational assignment, or training policies and practices be changed to accommodate national trends in BMI among enlistment-age youth?

C. SCOPE, LIMITATIONS AND ASSUMPTIONS

The value of the thesis is to better shape the way recruiting is conducted in order to ensure the best success for the sailors entering the Navy, through gaining an understanding of the impact of BMI on attrition. Some data on indications of a recruit's likely success during the first term of enlistment were not available for this research. The Navy offers recruits the ability to have some disqualifying factors waived. The thesis is not able to investigate to what extent the individuals in the study may have exercised this option. The thesis uses the available data to give the most accurate results for analysis.

1. Scope

The thesis focuses on the first-term attrition of Navy enlisted personnel. The population studied is those enlistees who separated prior to the completion of a first-term, and those who remained in the Navy. Historically, the Navy tends to lose between one-quarter and one-third of its recruits during the first term of service. Half of these discharges occur during the first 12 months of a Navy recruit's enlistment contract. Using height and weight data provided by Defense Manpower Data Center (DMDC) in the cohort attrition file, the BMI of Navy recruits is calculated and used to determine its relationship with first-term attrition.

The thesis focuses on first-term attrition behavior, in combination with BMI, for recruits with various demographic characteristics, including gender, race/ethnicity, education tier, AFQT scores, and age, among others. Additionally, the analysis examines the length of service at the point of discharge, the reasons for discharge, and the occupational assignment.

2. Limitations

Height and weight measurements for sailors upon completing their medical examination are often updated with their measurements immediately prior to their departure for boot camp (Buddin, 2005). In other words, the improvements in physical performance may not be captured based on the time they spent in the delayed entry program (DEP) or any pre-boot camp training. Thus, an adequate representation may not be available for an analysis of contributing factors to an improved BMI. The number of sailors who may attrite for other reasons may also be potentially impacted, which may render BMI not as significant a factor as believed.

Within the DMDC cohort attrition data, medical waivers could have been given to those who did not meet physical standards. These waivers may also include personnel who lead a healthy lifestyle, but have higher muscle mass and still require a waiver because of the current BUMED policy. Without having access to data on whether medical waivers were given, the accuracy of the analysis could be altered. Additionally, the data could show a greater number of individuals with high BMI not at risk for attrition due to poor health.

3. Assumptions

For potential recruits waiting for accession, individuals are not allowed to leave the DEP if they do not meet the physical standards. Thus, recruits end up staying longer while they attempt to improve their fitness level. Prior research from the RAND Corporation shows that the length of time in DEP can also be a large contributing factor for attrition because recruits have more time to decide they want to get out of the military (Buddin, 2005). Additionally, it can be assumed that despite the standard of only accessing physically compliant recruits, some recruits are allowed to access with a medical waiver in their record.

For some of the observations, medical waivers are not possible, but medical flag codes are assigned because the healthcare provider conducting the initial medical screening may have noted an issue warranting a medical flag code. The issues may not have always been severe enough to require a medical waiver. Among the flag codes was one assigned for body mass. In this case, a recruit may have been out of height and weight standards, but after reviewing the body type, it was flagged to note the individual did not actually violate the physical standards. It would have been up to the healthcare provider to assess the need for a medical waiver, when it may not be a blanket policy to request the waiver.

D. ORGANIZATION OF THE STUDY

Chapter II of the study reviews prior studies on attrition and its correlation with BMI, along with studies that address height and weight measurements and its relationship with work performance. Chapter III describes the data file used and the data, defines the dependent and independent variables used in the analysis, and provides the analytical methodology that should result from the data. Chapter IV describes the results of the regression ran to best determine attrition. Chapter V provides conclusions and recommendations based on the analysis.

II. LITERATURE REVIEW

This chapter highlights articles that lay the groundwork for the importance of maintaining weight standards and the implications for having a healthy lifestyle, with research on potentially adverse effects of becoming overweight or obese. This chapter is comprised of four sections. The first section looks at a previous study that examines demographics that influence first-term attrition. This sets the groundwork for the research of this thesis. Despite the timeframe in which the studies were published, many of the military policies are still valid, and thus create a parallel in which to base the information of this thesis. The next two sections look at weight problems and the impact they have on work-related stress, and offer recommendations to help alleviate work stressors. The last section looks at the effect body mass indices have on cognitive functions and offers insight to different types of body measurements used in measuring body mass. Despite the various military branches reported and the viewpoints from the civilian workforce seen in some of these studies, the Navy's potential shortcomings are pointed out when relating to preparing sailors for the physical and mental demands of the jobs they will have. Methods are offered to help allow sailors to preserve their bodies and minds during strenuous operational tasks.

A. WEIGHT PROBLEMS AND ATTRITION OF HIGH-QUALITY RECRUITS

In a study published by the RAND Corporation, Buddin (1989) examines what impact, if any, weight problems had on the likely attrition of potential recruits. At this time, there were heavily enforced weight restrictions. Buddin looks to see if these overweight recruits had a higher chance of attrition. His study shows that after their initial military training (boot camp), weight differences were much less of an effect on attrition among men; for women, no significant effect occurs at any point in the beginning process of enlistment. Buddin suggests this could be a result of a sufficient weeding out process where those who make it through boot camp and/or DEP are more inclined to finish the term of their enlistment. His study specifically looks at the general population ages 17–22 years. According to Buddin (1989), among Americans between 17 and 22 years of age, 20 percent of women are ineligible to enlist (only 14 percent are ineligible due to being overweight) whereas 14 percent of men are ineligible.

The data from Buddin's 1989 study included all high-quality accessions (those with a high school diploma who also score above the 50th percentile on the AFQT) from FY82 to FY85 and also ran separate regressions by service, gender, entry year, and training phase (basic, technical, and post training). He uses logistic regression because the dependent variable (attrition) was dichotomous. Buddin concludes that, in the Army, medically-deemed overweight men had much higher training attrition rates than men who had no weight issues. His findings indicated that in the Navy and Air Force, overweight men did not fare as badly, but they did have attrition rates above the average (Buddin, 1989). For women across branches, weight differences have little effect on attrition; as the results in this thesis show, there are greater parameters for physical standards for women that include a wider fitness range in which to fall. This thesis similarly examines the relationship between BMI and first-term attrition, by controlling for similar personal and demographic characteristics. This thesis also includes recommendations for policy changes that impact sailors at a time when unemployment is low, while offering to maintain achievable standards for today's sailor.

Buddin's study looks at cohort data from fiscal year (FY) 82 through FY85. At the time of the study, standards were more relaxed and Americans could make it through training based on the military operations of that time. Attrition had been steady between 15–19 percent; whereas, more recently, attrition has been almost double (Moore, 2009). The Navy conducted operations that required a greater amount of personnel in the enlistment pool. With unemployment rates at a record high of over 10 percent in 1983, it is not a surprise many young adults turned to the military to resolve their financial issues (U.S. Bureau of Labor Statistics, 2014). Buddin also mentions an important distinction between the identification of the military and civilian "overweightedness." Among the cohort of female high-quality recruits in Buddin's study, the range of BMI is from 22 to 31, with an average of 28. Based on military standards, five times as many woman are excluded as men in the general 17–22 age group (Buddin, 1989). This difference drastically reduces the number of high-quality candidates, which can be detrimental to future retention. It is important to make a distinction by gender for the number of recruits who fall within this standard, even though the National Heart, Lung, and Blood Institute categorizes the typical "overweight limit" at having a BMI greater than 30 for both men and women ("Calculate Your BMI," 2014). While, this is the national upper limit, Buddin uses a different standard for overweight BMI than prescribed by civilian medical practice where the upper limits for men and women are 26 and 31, respectively.

Buddin also talks about tighter recruiting standards that would result in substantially reducing the military eligibility enlistment pool. This would in turn increase the cost for future recruiting and make it more challenging to reach some of those high-quality applicants. At the time of Buddin's research, the Army recruiting experience suggested that special programs (e.g., Delayed Entry Program) might help mitigate some of the attrition issues for those recruits with noted weight issues. These programs could also provide greater resources for achieving and maintaining adequate weight (Buddin, 1989). Today, more programs exist for the Army, but they are often only available for a specific Military Occupation Specialty (MOS) and not for all soldiers who may need the assistance to become healthier.

During the time of Buddin's study, physical standards were more restrictive for women than for men. Only about 20 percent of women from 17–22 years of age among the general population were ineligible under military weight standards, while 14 percent of this same population were medically overweight from the civilian standpoint, which leads to less variation in the body mass among female recruits (Buddin, 1989). The significance of this relationship among women should clarify why a smaller distribution of weight variation occurs in the analysis of BMI and its effect on attrition for today's sailors. Along with shrinking the pool of applicants, while sailors are already working, policy changes and enforcement of physical standards can arise. This then leads to more sailors who have made it through Navy training, but now cannot meet the physical requirements to stay. Thankfully, many of the weight issues appear to be getting corrected during basic training, although this is likely through attrition prior to completion of training or physical conditioning.

The parallel that is drawn between Buddin's (1989) study and this thesis is to look at the methods for analyzing potential Navy applicants. Previously, there was less need for an extensive number of applicants and thus more restrictive standards were upheld in order to get the best of high-quality applicants. More recently, there has been more breadth to the types of enlisted applicants, which provides a more diverse force. While this thesis looks at current trends of BMI and first-term attrition, there are also policy recommendations that offer up methods to maintain high performance standards for sailors, while not losing high-quality talent in the process.

B. STRENGTH AND CONDITIONING FOR FEMALES IN THE MILITARY

Despite the insignificant differences among females in the military and the impact weight control has on stress levels and potential to remain in the military as supported by a study conducted by Sauers (2014) it is still an important issue to discuss. Whether the body type of a female may not on its own incur higher levels of stress, the first course of action in stress mitigation should be how to best equip female and male sailors alike for the workplace. Sauers talks about how specifically in the Army, it is up to the strength and conditioning specialist to ensure that the physical training (PT) program considers different aspects of soldiers' demands of daily life to prepare these soldiers to perform their duties to the best of their ability. It also helps to ensure adequate recovery and positive progression occurs, as well as identifying the risks of overtraining that can lead to injury and minimizing these risks (Sauers, 2014). Such a focus is not currently seen in the Navy, even as growing mission areas require sailors, females included, to be more physically prepared. The disconnect between what the Army and what the Navy are doing, is not preparing all military branches to be as capable to endure similar types of physical demands brought on by mission areas being performed across the spectrum of military occupations.

Sauers begins by stating that the Army has been conducting evaluations of combat MOS tasks to determine the physiological demands of each specialty occupation that will help shape the foundation and specialization of the Army PT program (2014). As the barrier walls that limited the types of MOS that could be held by a woman fall, it is not uncommon for a woman to engage in tasks such as carrying heavy loads over long distances, sprinting short distances, carrying personnel to safety, and lifting heavy objects repeatedly. According to Sauers, designing a program that targets these needs will prove to be highly effective at ensuring specific care is being taken. Typically, when conducting Army unit level PT, emphasis is only placed on aerobic exercise and muscle endurance, which does not target strength, agility, and power-training. These missing components that directly relate to tasks these soldiers can expect to see during training or deployment can easily result in injury and lost training days (Sauers, 2014).

Sauers notes that when introducing some resistance training in groups that perform physically demanding jobs, this can reduce gender differences in performance (Kraemer et al., 2004); it can be targeted toward those Navy-specific mission areas, such as VBSS, where participation is not strictly limited to males, but allows for females to perform the exact same job functions. For the sailors nominated or who volunteer for participation in the VBSS mission, there is a rigorous training program including Security Reaction Force-Basic (SRF-B), Security Reaction Force-Advanced (SRF-A), and Non-Compliant Boarding (NCB) School, all totaling eight weeks of training away from the sailors' primary shipboard duties (Rank, 2012). Each team consists of at least six members who may go through the training pipeline separately, but must complete the NCB School together. Each ship must also have at least two fully qualified teams to be mission certified.

This VBSS training in the past has been taught by former SEALS, Army Rangers, Marine Recon, and other military "elites" who have it built into their occupational training pipelines, but only a small portion of Navy sailors receives such beneficial training. Some of the training topics covered that can be useful to any sailor to maintain strength and conditioning are safety, water survival, physical training/defensive tactics, caving ladder climbing, rappelling, and tactical movements (Rank, 2012). Creating a way to increase the number of personnel capable of performing the VBSS team duties and care for their bodies—with the help of military specialists—will make it possible to deepen the bench of adequate sailors and keep them healthier in the process.

As time progresses, it can be expected that more and more physically demanding occupations will continue to open for females; thus, the integration of training should begin as soon as possible. The study also mentions that for the Army, considering that women are integrating into broader MOSs that are often physically demanding and performing their roles in more dangerous and hostile environments, appropriate physical fitness must be the basis for unit physical and operational readiness (Sauers, 2014). A similar mindset should go for any physically demanding occupation regardless of branch. This information is valuable to this thesis as the Navy does not offer the same type of rigorous training for sailors. In the past, when mission areas like VBSS were not conducted as a supplemental occupation by sailors onboard ships, and there were far fewer females in the Navy, this was less an issue. Today, females make up a higher percentage of the force and are more capable of performing physically demanding tasks. While the burden is now being shared among all sailors, the stresses of work and life can still abound. Utilizing methods to help our sailors cope with those stressors, while aiding in their physical training will surely usher the Navy to better care for sailors, as the Army has proven for its soldiers.

C. WORK STRESS, WEIGHT GAIN, AND WEIGHT LOSS

A study published by the *International Journal of Obesity* (Kivimaki et al., 2006) initially talks about previous research that focuses on the premise that there is an association between stress and weight change. The study looks at British civil servants, a total of 7965 participants—5547 men and 2418 women. Cohort participants were middle-aged civil servants from 35–55 years of age. At the conclusion of the study (Kivimaki et al., 2006), no direct link is made to suggest stress can also cause people to change eating habits that results in weight change.

As previously stated, the study sample in Kivimaki et al. looks at men and women between 35 and 55 years of age. While this is not the demographic at which this thesis looks, the relationship between stress and weight control is still a prevalent issue that Kivmaki et al. analyze. In the Navy, first-term sailors with minimal previous real-world stress prior to accession can still be compounded with work-related stress that can directly lead to unintended weight gain or weight loss. The study uses linear regression analysis to see if any associations occurred between different work stressors (high strain, high demand, and low job control) and BMI. The authors include other factors, such as age, work grade, and BMI at baseline. The study looks at what work stress did to a participant's BMI, including the possibility of losing weight due to stress. The study finds that for men in the leanest quintile (<22 BMI), high job strain and low job control were associated with weight loss. Conversely, among those men in the highest quintile (>27 BMI), these same stress indicators were associated with weight gain. Among women, the study finds no distinguishable interaction between stress and weight change (Kivimaki et al., 2006). The study finds the two biggest factors for inducing stress are high employer job demands and low job control. The study concludes that while there is evidence of weight change, no consistent association exists between job strain and BMI. Although Kivmaki et al. predominantly look at middle-aged males, these stress-related factors can often plague young sailors when reaching their first commands as they realize they are no longer able to determine what their daily workload will entail. This perpetuates the struggle for sailors to attain adequate physical training habits that have likely not yet been mastered by many 17- to 22-year-olds entering the Navy.

Contributing influences that further disrupt the desired healthy lifestyle are inadequate physical activity and lack of time to prepare healthier meal options, which aid in increased weight gain among people with chronic stress. Additionally, bidirectional effects between job strain and increased BMI were not seen in women, as the data were not statistically significant. Thus, work stress and the desire to leave the workplace did not lead to a change in weight among women because possibly women still take on the responsibilities of unpaid duties, such as child care. Therefore, future research can be done to look at stress outside of the workplace to see if there is an association between BMI and stress among women (Kivimaki et al., 2006).

The authors use logistics regression to determine the relationship between the three different work stressors and change in weight. The associations between the work stressors and weight gain/loss are all individually calculated for the heaviest and leanest quintiles of baseline BMI. This was also done for the combined three middle quintiles, which are used to depict significant interactions (Kivimaki et al., 2006). The study confirms that the work stressors predict continued weight gain in the top quintile that depicts overweight participants, and weight loss in the bottom quintile for those lean participants. There was no change that occurred in weight among the middle quintiles (Kivimaki et al., 2006).

Despite the skew in male to female analysis in the Kivimaki et al. study, it is apparent that the effect of work stress on weight control is still of concern. Work stress has a significant effect on weight gain or loss depending on the initial weight of a participant. In terms of women, it is possible that women could handle greater stress in the workplace; thus, analysis inaccuracies are possible as to how much the stress a woman feels comes from within or outside of work. For this reason, the effects of stress on women were statistically insignificant in the Kivimaki et al. study. A future study could look at distinguishing external factors to see how much of a factor work stress specifically has on women. The analysis in the Kivimaki et al. study is important to the study in this thesis because results from this analysis can better shape how to further mitigate work stressors. Evidence of the effects work stress can have on weight change for men is identified, which directly relates to the same types of stress that both male and female sailors endure. This can prove very crucial to the future of the Navy because those recruits who are just entering are faced with the same work stressors—high strain, high demand, and low control—on a daily basis. Many sailors meeting their commands on deployment are immediately thrown into a high strain and high demand environment, which exacerbates stress levels and their lack of control over the operational schedule with no time to decompress. Mitigating these issues and providing ways to alleviate stress will help to nurture sailors ready and able to perform over longer periods of time.

D. LONGITUDINAL ANALYSIS OF OBESITY AND COGNITIVE FUNCTION

Gunstad et al. (2010) examine the differentiation in body mass calculations and its relationship with cognitive function. The first thing to note is differentiating between different types of obesity indices. Their study uses a samples size of about 1,700 participants and focuses simply on BMI (height and weight ratio) and waist-to-hip ratio (WHR), and both relationships these indices have with various cognitive exams. Currently, the Navy only conducts the neck-to-shoulder-to-waist ratio after a sailor does not meet height/weight standards, which does not always favor those still within healthy parameters in terms of other physical measurements. This is due to some body types being disproportionate, which may register higher ratio that makes a very muscular sailor appear to be unhealthy. It can end unfavorably for sailors who would have to conform to a measurement standard not widely used in other civilian medical realms. Gunstad et al. also discuss how excess weight is associated with reduced cognitive function. This is not to say that the less a person weighs, the more equipped that person is to perform well cognitively, but a point can be reached when excess weight can be disadvantageous (Gunstad et al, 2010).

Bias toward obesity can occur, as most prospective studies have relied solely upon BMI to determine levels of obesity. Moreover, more accurate body measurements can be influenced by various factors, including a waist circumference measurement and the WHR. The study by Gunstad et al. finds that these two measurements are more closely linked with adverse health outcomes than BMI (2010). Muscle mass also is a factor in the calculation of BMI that can skew a person who is actually within healthy body standards from a medical perspective, but the height/weight measurements are depicting a less favorable calculation. Medical waivers are still available for these people, as is the option to stay within pre-boot camp programs, such as DEP for longer periods of time until reaching acceptable measurements (Gunstad et al, 2010).

This Gunstad et al. journal article stands out because it proposes a wider analysis of body measurements in the hopes of more accurately identifying benefits or gaps when assessing cognitive function. It can show cause for the inaccuracies and negative effects of using solely the neck-shoulder-waist ratio for the Navy. Gunstad et al. discuss the relationship among three obesity indices and neuropsychological test performance; the hypothesis is that measures of central obesity (e.g., waist circumference and waist-hip ratio) can more likely be related to cognitive decline than purely BMI. The three measures Gunstad et al. use are: (1) BMI (height/weight), (2) weight and hip circumference, and (3) WHR. The neuropsychological tests used are the global cognitive function: mini-mental state exam, attention and executive function test, and memory: California verbal learning test. The results for cognitive function demonstrate that multiple indices showing obesity are associated significantly with poorer cognitive function in an individual. Additionally, higher BMI is shown to lead to poorer performance on both the mental status tests administered to participants. Higher waist circumference and WHR are also associated with the positive results on the blessed-dementia information-memory-concentration test (Gunstad et al., 2010). This result is normally seen in subjects who are much older, but the same can hold true nonetheless for persons of all ages if they still are unable to adequately monitor their physical health. A favorable result with obese participants finds obesity is associated with greater performance on visuospatial and attention abilities tests (Gunstad et al., 2010).

Gunstad et al. use longitudinal mixed effects regression analysis and shows that these obesity indices are associated with poorer performance in the aforementioned cognitive functions, which the study includes as global screening measures, memory, and verbal fluency tasks (2010). The reason for the use of mixed effects regression is to account for inconsistencies in measurement intervals across the study’s participants. Mixed effects are not necessary for the analysis in this thesis because this thesis tracks sailors from the time they accessed until their separation, should they have separated before the end of their initial contract.

The discussion that larger body composition is associated with poorer performance in global cognitive function, memory, and language, shows that obesity in and of itself is a risk factor for negative neurocognitive performance (Gunstad et al., 2010). This factor is important because not only are sailors being equipped to function as valuable assets to their command and to the military, but they are also making themselves more valuable assets to their occupational community, which will not come to fruition with the poor management of sailors, and incorrectly setting the bar in terms of measurement methods and failing to enforce its importance. As obesity is the leading preventable cause of death in the U.S., it is imperative that our sailors are adequately being measured to ensure they are not as risk for hurting themselves and others, along with ensuring they have proper mechanisms to remain an asset.

E. CHAPTER SUMMARY

Among the military-related articles—Buddin (1989), Sauers (2014), and Kivimaki et al. (2006)—there is a trend that exists in which greater first-term success is not directly a factor of sailors who are within physical standards. A greater factor in sailor success deals with their aptitude, and a cornerstone of this is in being a high-quality recruit. The term "high-quality" is geared toward recruits with a high school diploma or greater and a high AFQT score, and when introduced with the military variable, these individuals are still poised to perform well and have a greater likelihood of completing the first term. Sailors who are driven to do well historically have succeeded. Sailors who take care of themselves are historically the same ones who are driven to be well-rounded individuals who surpass the tasks at hand, including contractual obligations.

This is not to say that there is no hope for the rest of the sailors who may not be categorized as high-quality recruits. The Navy attracts a wide variety of people. We do not want to lose out on quality sailors, who are able and willing to work, simply because they do not fit a certain mold. Even if an individual does not look good from the initial assessment, there is still room for growth. For some, it is simply a matter of learning their strengths and using that to catapult themselves into success. As we look at the ways body composition correlates to first-term attrition, we can see what the best method for calculating composition is to fit individual sailors and give them the best chance for first-term success.

III. DATA METHODOLOGY

This chapter is divided into four sections. The first section describes the source of the data this thesis uses and details the observations that make up the sample. The second section looks at key variables that have been defined by previous studies on common predictors of attrition. The third section summarizes observations for the effect of race and gender on attrition. Lastly, this chapter outlines the derivative probit regressions used for analysis.

In order to examine the hypothesis that BMI affects the likelihood of first-term attrition for enlisted sailors in the U.S. Navy, this thesis uses data from Defense Manpower Data Center (DMDC) and the Personalized Recruiting for Immediate and Delayed Enlistment (PRIDE). The DMDC and PRIDE attrition data include demographic information on gender, race, age, marital status, height and weight (used to calculate BMI), date of accession and separation, and AFQT score. The data represents enlisted personnel from FY01 through FY09. Beginning the analysis from 2001 allows for a comparison between pre-9/11 recruitment characteristics and post-9/11 recruitment. The DMDC and PRIDE data are captured at the end of every month and are the official record of strength numbers for all branches.

A. DATA DESCRIPTION

DMDC and PRIDE obtained data primarily from the U.S. Military Entrance Processing Command (MEPCOM) enlisted personnel data files of new U.S. Navy and U.S. Marine Corps recruits. The data contain details of each individual during initial processing at military entrance processing centers and recruitment centers. For those who separated prior to completing their first contracted obligation, the data set includes an explanation for the cause of discharge and discharge date. The dataset contains 347,441 individual records for the FY01 to FY09 period.

The Navy enlisted recruiting age ranges from 17 to 34; thus, those not in this range are excluded from the dataset. This rule drops 199 observations. It is likely that any individual from the sample outside that range is in error or resulted from mitigating circumstances, which biases their attrition measurements. The analysis also drops individuals who enlisted at a pay grade of E-4 or higher. This thesis assumes that individuals enlisting at a pay grade of E-4 or higher have prior service or were reported in error because Navy recruits can only enlist up to E-3 (U.S. Department of Defense, 2015). This decision drops 2011 observations. BMI is calculated using the height (m^2) and weight (*kg*) of each remaining observation.

After calculating BMI for each observation, the analysis dropped all observations with a calculated BMI of less than 17. As individuals with a BMI less than 17.5 are considered anorexic, it is unlikely that these individuals' height and weight are correct ("Calculate Your BMI," 2014). This calculation drops 1,460 observations.

The minimum allowable AFQT score is 31. Thus, the analysis excludes all individuals with scores of less than 31 from the sample. These restrictions reduced the sample size to 343,771 observations. Table 1 summarizes the sample restrictions and the resulting sample size.

Table 1. Details of Observations Removed from Sample

Individuals Dropped	Number of Observations Removed	Explanation
Rank at Entry	2,011	Restricted sample to ranks E1–E3
Age Greater Than 34	199	Removed individuals outside the standard enlistment age
BMI Less Than 17	1,460	Removed individuals with erroneous information
Total Removed From Sample	3,670	

B. KEY VARIABLES

In line with the literature, this thesis creates 10 demographic characteristics. These characteristics are likely to statistically significantly affect first-term attrition. Table 2 depicts all variables by name and their definitions.

Table 2. Variables by Name and Definition

Variable Name	Variable Definition
BMI	Body Mass Index Value (range 19–43)
Female	= 1 if Female, = 0 if Male
White	= 1 if White; = 0 otherwise
Black	= 1 if Black; = 0 otherwise
Hispanic	=1 if Hispanic; =0 if non-Hispanic
Asian	= 1 if Asian; = 0 if non-Asian
Native	= 1 if Native American/Pacific Islander; = 0 if non- Native American/Pacific Islander
Other	= 1 if Other; = 0 if White, Black, Hispanic, or Asian
Hs_dip	= 1 if high school diploma graduate; = 0 if no high school diploma
Non_hs_dip	=1 if not a high school graduate; =0 if high school graduate
ged	= 1 if GED received; = 0 if no GED received
coll	= 1 if some college, associate's degree, bachelor's degree, or higher completed; = 0 if no college or higher completed
Married	= 1 if Married, = 0 if not Married
AFQT	Armed Forces Qualification Test score (range 31 to 99)
Age	Age in years (range 17–34)
Attrite	=1 if sailor left before 48 months of service =0 if sailor did complete first term
FY	Year of enlistment based on fiscal year, (range FY01 to FY09)
Height	Height at time of accession (range 59 in. to 81 in.)
Weight	Weight at time of accession (range 85 lbs. to 260 lbs.)
Tis	Length of completed time in service, in months
Wtkg	Weight calculated in kilograms (kg)
Htmt	Height calculated in meters (m)

1. Gender

The Female dummy variable takes a value of one for females and zero for males. This variable captures gender difference in attrition. In the past, females generally had higher attrition rates, while their variation in body mass tends to be smaller than males (Buddin, 1989). In 2014, 18 percent of first-term enlistees were women. By 2025, the Navy expects that 25 percent of enlistees will be women. The recruiting and retention of women is of importance to the Navy (Faram, 2015).

2. Race

A series of dummy variables indicates the race of the sailor. Prior research in this area has shown varying results of the effect that race has on likelihood of attrition (Buddin, 2005). The race variables are White, Black, Hispanic, Asian, Native, and Other as shown in Table 2. It is of interest to investigate how race impacts attrition over time.

3. Education

The "hs_dip" variable takes a value of one if the sailor completed high school, and is used as the base variable for education level. It takes a value of zero if the sailor dropped out of high school. The "non_hs_dip" variable takes the value of one if the sailor did not complete high school or receive a diploma. Another education variable is "ged" that represents sailors who received their GED, but did not finish high school. The "coll" variable represents sailors who finished some college, an associate's or bachelor's degree, or higher. For all these variables, a value of one is used if completed. It can be expected that high school graduates and higher learning individuals have lower attrition rates, thereby, negatively affecting attrition due to the motivation and determination these recruits possess to fulfill their obligation, despite research suggesting these individuals know of other, more challenging careers that await them outside the military, and do not finish their initial commitment in an effort to pursue opportunities outside the military (Wenger & Hodari, 2004). This expectation causes those with some higher education to seek more lucrative civilian opportunities, leading to a higher rate of attrition.

4. Marital Status

Marital statuses vary, which are divided into two categories of “married” for those who have a spouse they can be providing for (married, domestic partnership, interlocutory), and “single” for those who do not have a spouse they are providing for (single, annulled, divorced, legally separated, never married, widowed). Using the “married” variable, a value of one represents an individual who has a spouse while a zero is for someone otherwise single. It is expected that the desire to provide for a significant other encourage a sailors to fulfill their first-term commitment and not attrite based on studies that show a higher rate of retention for first-term enlisted personnel with spouses (Quester, Hattiangadi, & Shuford, 2006). While it is generally expected for males, studies have shown that married females do tend to have higher attrition rates than single females, which is likely because married females want to provide for their spouse from home or in the civilian sector (Wenger & Hodari, 2004).

5. AFQT

The “AFQT” variable is a continuous measure of the score of a recruit beginning at a score of 31. All scores below 31 are dropped from the sample, and they range up to a score of 99. It can be expected that a high AFQT score also negatively affects attrition during the first term.

6. Age

The “age” variable is a continuous measure of the age of a recruit. Recruits outside the range of 17 to 34 years of age are dropped from the sample. With this variable, it can be expected that age also significantly affects attrition rates. Younger recruits may have a higher tolerance for following instructions and orders from those of higher ranking service members, while older recruits are expected to be more capable of making better decisions and having an increased likelihood of completing their first term. Previous studies have demonstrated that younger recruits are more likely to stay in the Navy, which negatively affects attrition (Quester et al., 2006). Additionally, the analysis is for the time immediately post-9/11. This timeframe could be seen as a period of increased patriotism when older recruits had more invested in making it through their initial contract.

7. Fiscal Year

FY is a dummy variable that indicates the year an individual enlisted. The range for this analysis is FY01 (beginning on October 1, 2000) to FY09 (ending on September 30, 2009). Individual cohort years are used with the variable “coh_YY” with YY representing the years 01 to 09, and another variable “post2001” that represents all years combined aside from FY01. The purpose of the study is to concentrate on post-9/11 accessions. Thus, using FY01 serves as a control for the number of accessions and quality of recruits prior to September 11, 2001.

8. BMI Number

The “BMI” variable is a continuous measure of the BMI of a recruit starting from a value of 17. This thesis hypothesizes that recruits’ BMI significantly affect their attrition. As previously mentioned, the Navy has different standards for what is considered “overweight” for a male (BMI>26) and a female (BMI>31), yet many observations are greater than 26 for males, which Figure 1 depicts. The distribution for female BMI depicts an average of about 27.5 as shown in Figure 2, and overall BMI frequency has two peaks, one at around 22 and 28 as shown in Figure 3.

Figure 1. BMI Distribution for Males

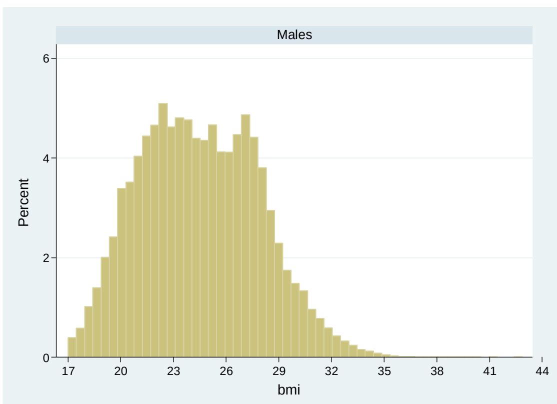


Figure 2. BMI Distribution for Females

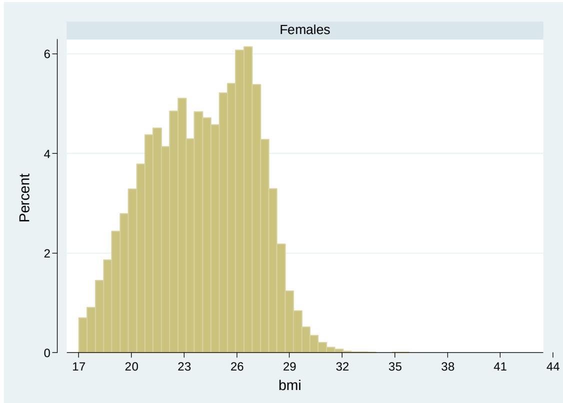
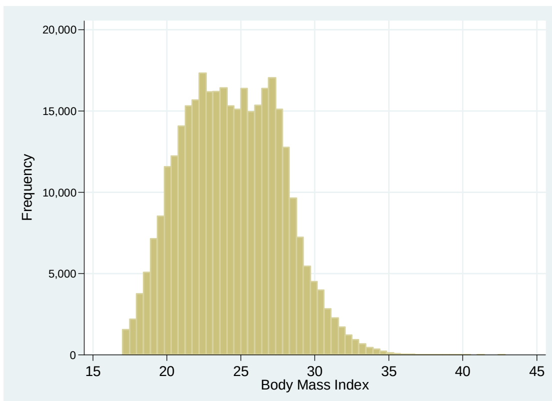


Figure 3. Frequency of Body Mass Index among Sailors



9. Ratings

The 34 various enlisted ratings found in the dataset are displayed as follows. These are not run individually, but are noted in the regression analysis.

Admin Clerk
Aviation
Seabee Engineer
Combat Systems
Communications
Culinary Specialist
Damage Control
Electricians Mate

Internal
Communication
Instructor
Intelligence
Information Tech
Master at Arms
Missile Technician
Machinist Mate
Machinery Repair

Medical
Meteorology
Musician
Nuclear Operations
Specialist
Ordinance
Photography
Postal Clerk
Parachute Rigger

Radar Tech
Religious Program
Specialist
Seaman
Security
Ship Servicemen
Sonar Tech
Special Operations
Supply Clerk
Undesignated

10. Attrite

Attrite is the dependent variable when running the regression analysis to notice whether BMI matters significantly in determining if sailors attrite during their first term. Attrite is regressed as a function of the other variables. For the analysis, attrition takes a value of one if a sailor completes less than 48 months of service.

C. DESCRIPTIVE STATISTICS

The data included 343,771 observations. The descriptive statistics for the model variables are shown in Table 3.

Table 3. Descriptive Statistics of Model Variables (N = 343,771)

Variable Name	Mean	Std. Dev	Min value	Max Value
BMI	24.416	3.336	17.006	42.860
Female	0.178	0.383	0	1
White	0.552	0.497	0	1
Black	0.181	0.385	0	1
Hispanic	0.153	0.360	0	1
Asian	0.034	0.182	0	1
Native	0.016	0.126	0	1
Other	0.060	0.237	0	1
Hs_dip	0.849	0.358	0	1
Non_hs_dip	0.049	0.217	0	1
ged	0.038	0.190	0	1
coll	0.061	0.239	0	1
Married	0.063	0.242	0	1
AFQT	61.700	18.347	31	99
Age	20.129	2.910	17	34
Attrite	0.343	0.475	0	1

1. General Observations

The sample is comprised of 343,771 individuals. Within this sample, 117,954 or 34.31 percent separated prior to the end of their first obligation. Of the 117,954 separations, males made up 94,553 observations and females 23,401 observations. The average BMI for the Navy is 24.42, which is below the national average of 26.5 for U.S. adults (Calculate Your BMI, 2014). It is reasonable to assume that the physical fitness of service members is higher than that of the general population (Moore, 2009).

2. Race/Ethnicity

This variable shows the number of accessions by race over time. Whites are the majority of enlistees, followed by Blacks and Hispanics as shown in Table 4.

Table 4. Number of Accessions by Race and FY

	FY01	FY02	FY03	FY04	FY05	FY06	FY07	FY08	FY09
White	28,457	26,296	17,296	21,116	20,019	19,638	18,597	18,694	18,588
Black	10,451	7,751	8,026	7,248	6,422	5,455	5,205	5,910	5,686
Hispanic	6,424	5,606	4,523	5,865	5,971	5,809	6,457	6,812	5,199
Asian	1,901	1,727	492	1,383	1,491	1,289	1,165	1,237	1,107
Native	1,849	1,491	121	395	308	285	351	384	346
Other	712	598	3,342	2,480	2,523	2,658	2,344	2,711	3,137
Total Accessions	49,794	43,469	33,800	38,487	36,734	35,134	34,119	35,748	34,063

3. Gender

Another important distinction that needs to be made is the difference in being within the Navy physical standard and how it varies by gender. As previously stated, the upper limit for male BMI is 26. The occurrence of male overweight BMI (BMI>26) by race and FY is shown in Table 5. When looking at the percentages of those overweight by the sailor's race, an upward trend is seen in the number of male sailors who exceed the allotted BMI. FY08 and FY09 saw the highest percentages of overweight males for every race. The issue that many potential male recruits may face is that they find they do not meet the Navy physical standards for healthy weight only after they have met civilian medical standards. This disparity can lead to these sailors needing medical waivers if they still want to enlist. Very few females are categorized as overweight, as the data contained very few females who had a BMI greater than 31. Only 41 females in the entire dataset were categorized as overweight, and FY08 and FY09 also saw the most with 11 and 10 females having a BMI of greater than 31, respectively.

Table 5. Male Overweight Body Mass Index by Race

	FY01	FY02	FY03	FY04	FY05	FY06	FY07	FY08	FY09
White	**1,084**	**969**	**602**	**747**	**635**	**697**	**721**	**1,140**	**1,048**
% of Sample	3.81%	3.68%	3.48%	3.54%	3.17%	3.55%	3.88%	6.10%	5.64%
Black	**762**	**514**	**438**	**475**	**398**	**403**	**389**	**562**	**503**
% of Sample	7.29%	6.63%	5.46%	6.55%	6.20%	7.39%	7.47%	9.51%	8.85%
Hispanic	**294**	**254**	**202**	**202**	**247**	**241**	**368**	**558**	**438**
% of Sample	4.58%	4.53%	4.47%	3.44%	4.14%	4.15%	5.70%	8.19%	8.42%
Asian	**63**	**58**	**13**	**35**	**47**	**43**	**49**	**65**	**62**
% of Sample	3.31%	3.36%	2.64%	2.53%	3.15%	3.34%	4.21%	5.25%	5.60%
Native	**61**	**48**	**6**	**21**	**18**	**10**	**26**	**27**	**29**
% of Sample	3.30%	3.22%	4.96%	5.32%	5.84%	3.51%	7.41%	7.03%	8.38%
Other	**39**	**17**	**151**	**85**	**69**	**92**	**107**	**183**	**178**
% of Sample	5.48%	2.84%	4.52%	3.43%	2.73%	3.46%	4.56%	6.75%	5.67%

D. ESTIMATION MODELS

The general model for this thesis examines the hypothesized relationship between BMI and first-term attrition while controlling for the demographic factors of:

Attrition = f (BMI, gender, race, marital status, age, education, fiscal year, ratings).

Several probit regressions are developed to test the hypotheses. The first regression *(1)* looks at attrition as a function of major demographics that have been known to be significant in predicting attrition. Wenger and Hodari (2004), Buddin (2005), and Quester et al. (2006) provide similar key factors that the regression uses: gender, age, marital status, and race. The second regression *(2)* includes BMI, along with the demographics, education, and AFQT. The third regression *(3)* looks at attrition as a function of the major demographics, education, AFQT, BMI, all occupational ratings, and FYs differing from FY01. The fourth regression *(4)* looks at attrition as a function of the major demographics, education, AFQT, ratings, and the interaction between BMI and all those who enlisted after 9/11. With the exception of the last regression, each regression also includes all cohort years of accession with 2001 as the base year. Lastly, these regressions are rerun for each gender separately.

The following equations are used.

$$\begin{aligned} attrite = \phi(&\beta_0 + \beta_1 female + \beta_2 age + \beta_3 married + \beta_4 black + \beta_5 hispanic + \beta_6 asian \\ &+ \beta_7 native + \beta_8 other + \beta_9 coh\_02 + \beta_{10} coh\_03 + \beta_{11} coh\_04 + \beta_{12} coh\_05 \\ &+ \beta_{13} coh\_06 + \beta_{14} coh\_07 + \beta_{15} coh\_08 + \beta_{16} coh\_09 + \varepsilon) \end{aligned} \qquad (1)$$

The purpose of the first equation is to validate previous research that denotes historical predictors of attrition. Once affirming the likelihood of attrition based on previously accepted demographics factors falls within the typical average of about 33 percent (Wenger & Hodari, 2004), additional factors can be included to follow on equations.

$$\begin{aligned} attrite = \phi(&\beta_0 + \beta_1 female + \beta_2 age + \beta_3 married + \beta_4 black + \beta_5 hispanic + \beta_6 asian \\ &+ \beta_7 native + \beta_8 other + \beta_9 coh\_02 + \beta_{10} coh\_03 + \beta_{11} coh\_04 + \beta_{12} coh\_05 \\ &+ \beta_{13} coh\_06 + \beta_{14} coh\_07 + \beta_{15} coh\_08 + \beta_{16} coh\_09 + \beta_{17} non\_hs\_dip \\ &+ \beta_{18} ged + \beta_{19} coll + \beta_{20} afqt + \beta_{21} bmi + \varepsilon) \end{aligned} \qquad (2)$$

The second equation adds to it education and AFQT, along with BMI. Grouping education and AFQT together is done because historically recruits who score well on the AFQT also have higher levels of education or at least completed high school with a diploma. BMI was also added to show the significance it has in affecting likely attrition over the span of additional variables in subsequent equations.

$$
\begin{aligned}
attrite = \phi(&\beta_0 + \beta_1 female + \beta_2 age + \beta_3 married + \beta_4 black + \beta_5 hispanic + \beta_6 asian \\
&+ \beta_7 native + \beta_8 other + \beta_9 coh\_02 + \beta_{10} coh\_03 + \beta_{11} coh\_04 + \beta_{12} coh\_05 \\
&+ \beta_{13} coh\_06 + \beta_{14} coh\_07 + \beta_{15} coh\_08 + \beta_{16} coh\_09 + \beta_{17} non\_hs\_dip \\
&+ \beta_{18} ged + \beta_{19} coll + \beta_{20} afqt + \beta_{21} bmi + + \beta_{22} AllRatings + \varepsilon)
\end{aligned} \qquad (3)
$$

The third equation only introduces the addition of Navy ratings. This is specifically important because there is likely a change in attrition on the basis of the type of occupational rating a recruit attains upon entry. In order to see if certain ratings are more predisposed to early attrition, special attention is first paid to the affect ratings as a whole have on attrition.

$$
\begin{aligned}
attrite = \phi(&\beta_0 + \beta_1 female + \beta_2 age + \beta_3 married + \beta_4 black + \beta_5 hispanic + \beta_6 asian \\
&+ \beta_7 native + \beta_8 other + \beta_9 non\_hs\_dip + \beta_{10} ged + \beta_{11} coll + \beta_{12} afqt + \beta_{13} bmi + \\
&+ \beta_{14} AllRatings + \beta_{15} post2001 + \beta_{16} bmi * post2001 + \varepsilon)
\end{aligned} \qquad (4)
$$

The final equation introduces variables consisting of those who enlisted after September 11, 2001, and the interaction between BMI and those who enlisted after 9/11. Because of the terrorist attacks that plagued the United States, many people felt an extra sense of patriotism and decided to join the military. The inclusion of this particular variable is used to see if attrition was negatively affected by post 9/11 recruits, and if BMI was influenced among those individuals.

E. CHAPTER SUMMARY

The regression analysis is vital to mathematically paint the picture of the level of integration BMI has on attrition. The research ventures to accomplish two things. The first is to validate previously held statistics of predictors of attrition while including BMI in an effort to look at a more often neglected characteristic factor of BMI. The second is to see the effect 9/11 had on sailors' willingness to complete their first-term even if statistically they should not have because they did not meet acceptable physical standards. Once accounting for common errors in observations, dropping them from the raw data will leave the concentrated sample of individuals that are used to look at gender differences, differences among educational levels, differences in race, and whether some accession years were more fortuitous that others.

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IV. ANALYSIS

Prior to detailing the effect of BMI on first-term attrition of Navy sailors, this thesis first reviews demographics to validate the analysis model according to previous research on topics of Navy sailors and recurring independent variables that affect attrition. The subsequent models include the BMI variable. The fifth model includes the interaction between BMI and all those who enlisted post-FY01. Derivative probit regression analysis is run for all estimation models to look at the one-unit affect the independent variables have on the likelihood of attrition. The Appendix shows the probit regression analysis for all models.

A. REGRESSION MODELS PREDICTING THE LIKELIHOOD OF ATTRITION

Based on the regression analysis found in Table 6, the demographics hold consistent with previous research on attrition. The influence of BMI in later models is consistent with the thesis hypothesis that an increase in BMI positively affects attrition. For the interaction between BMI and those who enlisted after 9/11, a relationship exists that shows sailors who entered the Navy after FY01 increase their likely of attrition by 0.3 percentage points as BMI increases by one unit.

Table 6. Regression Results for Navy First-term Attrition

VARIABLES	(1) Demographics	(2) Demographics Education BMI	(3) Demographics Education BMI Ratings	(4) All Variables BMI*Post_2001 Interaction
age	-0.002***	-0.001***	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
married	-0.011***	-0.020***	-0.027***	-0.028***
	(0.004)	(0.004)	(0.004)	(0.004)
female	0.048***	0.051***	0.054***	0.054***
	(0.002)	(0.002)	(0.002)	(0.002)
black	-0.002	-0.027***	-0.021***	-0.021***
	(0.002)	(0.002)	(0.002)	(0.002)
native	-0.033***	-0.041***	-0.039***	-0.039***
	(0.006)	(0.006)	(0.006)	(0.006)
asian	-0.117***	-0.126***	-0.119***	-0.119***
	(0.004)	(0.004)	(0.004)	(0.004)
other	0.008**	0.005	0.003	0.003
	(0.004)	(0.004)	(0.004)	(0.004)
hispanic	-0.085***	-0.099***	-0.074***	-0.074***
	(0.002)	(0.002)	(0.002)	(0.002)
coh_02	-0.031***	-0.027***	-0.019***	
	(0.003)	(0.003)	(0.003)	
coh_03	-0.036***	-0.024***	-0.017***	
	(0.003)	(0.003)	(0.003)	
coh_04	-0.046***	-0.028***	-0.012***	
	(0.003)	(0.003)	(0.003)	
coh_05	-0.044***	-0.024***	-0.013***	
	(0.003)	(0.003)	(0.003)	
coh_06	-0.042***	-0.019***	-0.002	
	(0.003)	(0.003)	(0.003)	
coh_07	-0.066***	-0.049***	-0.035***	
	(0.003)	(0.003)	(0.003)	
coh_08	-0.047***	-0.026***	-0.012***	
	(0.003)	(0.003)	(0.003)	
coh_09	-0.069***	-0.044***	-0.024***	
	(0.003)	(0.003)	(0.003)	
non_hs_dip		0.128***	0.123***	0.123***
		(0.004)	(0.004)	(0.004)
ged		0.152***	0.145***	0.145***

VARIABLES	(1) Demographics	(2) Demographics Education BMI	(3) Demographics Education BMI Ratings	(4) All Variables BMI*Post_2001 Interaction
		(0.005)	(0.005)	(0.005)
coll		0.027***	0.037***	0.037***
		(0.004)	(0.004)	(0.004)
afqt		-0.002***	-0.003***	-0.003***
		(0.000)	(0.000)	(0.000)
bmi		0.002***	0.002***	-0.001
		(0.000)	(0.000)	(0.001)
Ratings	No	No	Yes	Yes
post2001				-0.092***
				(0.018)
bmipost2001				0.003***
				(0.001)
Observations	343,771	343,771	343,771	343,771

Notes: All regressions were estimated via Derivative Probit (Dprobit). Standard errors appear in parentheses.

*** significant at 1% ** significant at 5% * significant at 10%

1. Attrition As a Function of Demographics

The first regression looks at the probability of attrition considering the following independent variables: Age, Married, Female, Black, Hispanic, Asian, Native, and Other. The White variable acts as the control group for the varying ethnic races. These demographic variables are of primary importance because this thesis initially looks at how the independent variables influence the probability of attrition within the data analysis. All variables in the first model are binary variables except for age.

The resulting coefficients do not say much on their own in relation to the base variables so we need to estimate at the margin to interpret the estimate coefficients. To note truly the effects of the variables on attrition, probit regression is run. Using probit analysis, the marginal effects of each independent variable display the change for one variable by one unit. Table 6 shows how attrition rates are predicted when controlling for

BMI and other factors. At first glance, all variables, except the Black race variable, are significant at the 1 percent level of significance.

While the estimated coefficient for Age is negative and statistically significant at the 1 percent level for models (1) and (2), it is not statistically significant in models (3) and (4) in Table 6. This result suggests that age negatively affects attrition likelihood; that is, a 1-year increase in age lowers estimated attrition by approximately 0.2 percentage points. This affect is, however, fragile to specification choice.

Married sailors are less likely to attrite during the first-term contract as compared to single sailors. Married sailors are about 1 percentage point less likely to attrite. This finding is robust across specifications and confirms the hypothesis that sailors can be seen as more inclined to stay in until the completion of their first-term potentially because they are providing in part or fully for a family. The estimated coefficient is negative and statistically significant at the 1 percent level of significance.

Females are more likely to attrite during the first-term contract relative to males. The estimated coefficient for the female dummy variable is positive and statistically significant at the 1 percent level of significance across the estimations (see Table 6). Females appear to be approximately 5 percentage points more likely to attrite.

The last of the demographics to be reviewed is race. In model (1), the estimated coefficient for the Black dummy variable is statistically insignificant. Therefore, when it comes to Black sailors, no statistically significant difference exists between their likelihood of attrition as compared to White sailors. Hispanic sailors are approximately 7 to 9 percentage points less likely to attrite than White sailors. Asian sailors are approximately 12 percentage points less likely to attrite than White sailors. Native American or Alaskan sailors are just over 3 percentage points less likely to attrite than White sailors. Sailors in the Other race category are about 1 percentage point more likely to attrite than White sailors. All the race variables are statistically significant at the 1 percent level of significance. This regression supports prior studies on the effect of demographics on the likelihood of attrition (Wenger & Hodari, 2004).

2. Attrition As a Function of BMI, Demographics, and Education

The second regression looks at the probability of attrition considering the following independent variables: Age, Married, Female, Black, Hispanic, Asian, Native, Other, a non-high school graduate, someone who attained a GED, some college completion or higher, AFQT, and BMI. With the addition of the variable BMI, it is possible to begin to see what significance, if any, BMI has on predicting the likelihood of attrition.

In model (2), a one-unit increase in BMI increases predicted attrition by 0.2 percentage points at the 1 percent level of significance. BMI does appear to positively and statistically significantly influence predicted attrition.

Sailors who did not receive a high school diploma are approximately 13 percentage points more likely to attrite than those who graduated high school and received a diploma. This percentage supports the hypothesis that not completing high school can be a significant factor in sailors not being able or willing to complete their first term of service. Those who received a GED are approximately 15 percentage points more likely to attrite than sailors who received a high school diploma. It is not startling to see the detriment that could be faced by recruits who did not complete their high school diploma. What is of interest, however, is that a sailor who did not finish high school has a better chance of first-term success than a sailor who has a GED. This statement supports research by Wenger and Hodari (2004) who found that those with completed education may have civilian job offers and do not necessarily need to fulfill their first term to ensure they have a job. A sailor who completed some college or attained a degree is approximately 3 percentage points more likely to attrite than someone with a high school diploma. Looking at AFQT, the probability of attrition decreases by 0.2 percentage points for every 1 point increase in the AFQT score.

Significant changes occur among some of the demographic variables as well with the inclusion of BMI and education. A married sailor is now 2 percentage points less likely to attrite compared to a single sailor; an increase of 1 percent. A Black sailor is approximately 3 percentage points less likely to attrite than a White sailor. These Black sailors were previously statistically no different than White sailors when only looking at demographic variables. Native American or Alaskan sailors are just over 4 percentage points less likely to attrite than White sailors, which is an increase of 1 percentage point. Hispanic sailors are approximately 10 percentage points less likely to attrite than White sailors; an increase of over 1 percentage point.

3. Attrition As a Function of Demographics, Education, BMI, and Rating

The third regression looks at the probability of attrition considering the following independent variables: Age, Married, Female, Black, Hispanic, Asian, Native, Other, a non-high school graduate, someone who attained a GED, some college completion or higher, AFQT, BMI, and all 34 ratings in the dataset. All variables in this model are binary, with the exception of age, BMI, and AFQT. Age is no longer statistically significant in predicting the likelihood of attrition.

This model includes all the variables from previous models and now includes ratings, as seen in Table 6. The probability of an individual characterized in the Other variable is not statistically different than the White variable in predicting attrition. Additionally, no statistical difference occurs as Age changes in the sample. All other variables are statistically significant at the 1 percent level of significance. A Hispanic sailor is now about 7 percentage points less likely to attrite compared to a White sailor; a decrease of about 2 percentage points. Native American or Alaskan sailors are just over 4 percentage points less likely to attrite than White sailors, which is an increase of 1 percentage point. No significant change occurs in the coefficients for the remaining demographics.

4. Attrition As a Function of BMI and Post-2001 Interaction

This regression looks at the probability of attrition among all previous dependent variables, but replaces the individual cohort years from 2002 to 2009 with the variable post 2001, which is compared to 2001. The individual FYs all negatively affect attrition, but looking at the interaction of BMI and all combined years after September 11, 2001, is of interest. This interaction shows the trend of all years after FY01 to see a relationship between BMI after FY01 and attrition. Previous models in this thesis show a positive relationship between BMI and attrition. This model looks at a specified period of BMI. All other variables are statistically significant at the 1 percent level of significance.

The variable post-2001 looks at the difference in sailors who accessed in 2001 as compared to all subsequent years. This thesis reviews how likely attrition shifted across pre-9/11 first-termers and post-9/11 first-termers. Although only the first year prior to September 11, 2001 is analyzed, it is still likely a change can occur in attrition behavior when looking at later years when first-term contracts are nearing their end.

As seen in Table 6, individuals who enlisted after FY01 are over 9 percentage points less likely to attrite than those who enlisted prior to FY01. Looking at the interaction between BMI and succession into the Navy post-9/11, entering after FY01 makes a sailor 0.3 percentage points more likely to attrite as BMI increases by one unit. This percentage is consistent with the hypothesis that an increase in BMI positively affects attrition. What is of interest is that previous regressions that look at individual cohort years show a negative effect on attrition. The influence of BMI for each year is statistically significant and shows a consistent positive increase.

B. ANALYSIS OF GENDER DIFFERENCES ON THE EFFECT OF BMI ON THE PROBABILITY OF ATTRITION

All the regressions are performed again; this time they are distinguished by gender. As mentioned previously, the reason to review each gender separately is because the Navy standards for BMI are set differently. The upper limit of acceptable BMI for males is 26, while the upper limit for females is 31. Looking back at Figure 2, it is apparent that the national average BMI for males is 24.5, and while the upper limit is 26, a decent percentage of sailors have a BMI that exceeds this upper limit. Females, on the other hand, have smaller differences among BMI, where the sample average is 23.96 (Figure 3). The regression results of attrition for males and females are shown in Table 7. The variables not of statistical significance are age (both genders), Other (for males), and some college completion or higher (for females).

Table 7. Regression Results for Attrition by Gender

VARIABLES	(1) All Variables for Males	(2) All Variables for Females
coh_02	-0.020***	-0.016**
	(0.003)	(0.008)
coh_03	-0.024***	0.019**
	(0.004)	(0.009)
coh_04	-0.022***	0.038***
	(0.004)	(0.009)
coh_05	-0.020***	0.019**
	(0.004)	(0.009)
coh_06	-0.009**	0.030***
	(0.004)	(0.008)
coh_07	-0.046***	0.020**
	(0.004)	(0.009)
coh_08	-0.022***	0.042***
	(0.004)	(0.008)
coh_09	-0.039***	0.042***
	(0.004)	(0.008)
black	-0.005*	-0.088***
	(0.003)	(0.005)
hispanic	-0.068***	-0.106***
	(0.003)	(0.005)
asian	-0.118***	-0.126***
	(0.004)	(0.010)
native	-0.035***	-0.058***
	(0.007)	(0.014)
other	0.006	-0.018**
	(0.004)	(0.008)
age	0.000	-0.001
	(0.000)	(0.001)
married	-0.042***	0.033***
	(0.004)	(0.009)
non_hs_dip	0.126***	0.088***
	(0.004)	(0.012)
ged	0.146***	0.130***
	(0.005)	(0.016)
coll	0.043***	-0.004
	(0.004)	(0.009)
afqt	-0.003***	-0.002***
	(0.000)	(0.000)
Ratings	Yes	Yes

VARIABLES	(1) All Variables for Males	(2) All Variables for Females
bmi	0.001***	0.006***
	(0.000)	(0.001)
post2001		-0.031
		(0.046)
bmipost2001	0.004***	0.002
	(0.001)	(0.002)
Observations	282,402	61,357

Notes: All regressions were estimated via Derivative Probit (Dprobit). Standard errors appear in parentheses.
*** significant at 1% ** significant at 5% * significant at 10%

Among the race variables, the one that varies the greatest is if a sailor is Black. The probability of attrition for males who are Black decreases by 0.5 percentage points, while the probability of attrition for a Black female sailor decreases by approximately 9 percentage points as compared to White sailors of the respective gender.

When looking at marital status, the probability of attrition increases by about 3 percentage points if a female is married. This increase is in almost complete contrast to the overall regression. However, for males, the probability of attrition decreases by about 4 percentage points. In terms of cohort year of accession, males are less likely to attrite if they entered the Navy after FY01. Females are more likely to attrite if they entered the Navy after FY01, with the exception of females who accessed in FY02.

In terms of education levels, one noteworthy difference from the overall sample is for females. If a female sailor completed some college or higher, it is not statistically different than if she just finished high school. For a male who completed some college or higher, his likelihood of attrition increases by about 4 percentage points compared to a male who received a high school diploma. This finding is slightly higher than the overall regression results for both genders and education. Looking at BMI, for women, every one-unit increase in BMI increases the likelihood of attrition by 0.6 percentage points.

For males, every one-unit increase in BMI increases the likelihood of attrition by 0.1 percentage points.

C. REGRESSION ANALYSIS BY EDUCATION LEVEL

In this section, we examine whether segregating the sample by education level affects the magnitude and statistical significance of BMI with regard to attrition as shown in the marginal effects from probit estimations in Table 8. In addition to the base model, four regressions models are used that looked specifically at the varying education levels. Prior research indicated the statistical significance education levels have on predicting attrition (Wenger & Hodari, 2004).

Table 8. Relationship between Attrition and BMI by Education Levels

VARIABLES	**(1) Non High School Diploma**	**(2) GED**	**(3) High School Diploma**	**(4) Some College and Higher**
bmi	-0.002	0.001	0.002***	-0.001
	(0.001)	(0.001)	(0.000)	(0.001)
coh_02	-0.010	-0.003	-0.023***	-0.041***
	(0.012)	(0.016)	(0.003)	(0.013)
coh_03	-0.047***	-0.044**	-0.019***	-0.051***
	(0.014)	(0.018)	(0.004)	(0.013)
coh_04	-0.029*	-	-0.017***	-0.049***
		0.052***		
	(0.015)	(0.018)	(0.004)	(0.013)
coh_05	-0.057***	-	-0.012***	-0.057***
		0.191***		
	(0.016)	(0.017)	(0.004)	(0.013)
coh_06	-0.068***	-0.039**	-0.008**	-0.072***
	(0.019)	(0.018)	(0.004)	(0.013)
coh_07	-0.068***	-	-0.038***	-0.095***
		0.061***		
	(0.017)	(0.017)	(0.004)	(0.013)
coh_08	-0.069***	-0.045**	-0.015***	-0.085***
	(0.016)	(0.019)	(0.004)	(0.013)
coh_09	-0.084***	-0.050**	-0.033***	-0.104***
	(0.018)	(0.020)	(0.004)	(0.012)
black	0.012	0.019	0.007***	0.013

VARIABLES	(1) Non High School Diploma	(2) GED	(3) High School Diploma	(4) Some College and Higher
	(0.012)	(0.015)	(0.002)	(0.009)
hispanic	-0.074***	-0.060***	-0.059***	-0.043***
	(0.011)	(0.014)	(0.002)	(0.010)
asian	-0.147***	-0.123***	-0.101***	-0.107***
	(0.021)	(0.030)	(0.005)	(0.013)
native	-0.029	-0.021	-0.035***	-0.037
	(0.025)	(0.032)	(0.007)	(0.024)
other	0.004	-0.018	0.006*	0.017
	(0.019)	(0.020)	(0.004)	(0.015)
female	0.017	0.069***	0.062***	0.038***
	(0.013)	(0.016)	(0.002)	(0.009)
age	-0.010***	-0.016***	0.001***	-0.005***
	(0.002)	(0.002)	(0.000)	(0.001)
married	-0.035**	-0.028*	-0.024***	-0.016
	(0.016)	(0.016)	(0.004)	(0.010)
Ratings	Yes	Yes	Yes	Yes
Observations	16,968	12,925	291,823	20,901

Notes: All regressions were estimated via Derivative Probit (Dprobit). Standard errors appear in parentheses.
*** significant at 1%   ** significant at 5%   * significant at 10%

1. High School Diploma Graduate

The regression results suggest that BMI only appears to affect the likelihood of attrition of those holding a high school diploma. Out of the 343,771 total observations, 291,823 individuals are high school graduates, which make up almost 85 percent of the sample. For individuals with a high school diploma, the estimated coefficient for BMI is positive and statistically significant at the 1 percent level. A 1-point increase in BMI is estimated to increase the likelihood of first-term attrition by 0.2 percentage points. One possible reason for the positive influence BMI has on attrition for high school diploma graduates could be the potential career opportunities available to the sailors should they not succeed in achieving and maintaining adequate height/weight standards.

Gender and marital status also vary when looking at specific education levels. When reviewing high school diploma graduates, being a female sailor has a greater influence in predicting the likelihood of attrition. This individual is about 6 percentage points more likely to attrite than a male if she has received a high school diploma, which is up from approximately 5 percentage points when controlling for all previous factors. As a married sailor, this individual is about 2 percentage points less likely to attrite than someone who is single if the sailor has received a high school diploma, which is down from approximately 3 percentage points in previous models. No significant changes occurred to any other of the previous variables.

2. Non-High School Diploma Graduate

For individuals without a high school diploma, no statistical differentiation occurs in predicting likely attrition based on BMI. When looking only at non-high school diploma graduates, being a married sailor has a greater influence in predicting the likelihood of attrition. As a married sailor, this individual is now approximately 4 percentage points less likely to attrite than someone who is single if the sailor has not received a high school diploma. No significant changes occur to any other of the previous variables.

3. General Education Development

Also, for individuals with only a GED, no statistical differentiation occurs in predicting likely attrition based on BMI. While BMI is not significant for those with a GED in predicting attrition, being a female sailor did have a significant effect on predicting the likelihood of attrition. When looking at a female sailor with a GED, this individual is approximately 7 percentage points more likely to attrite than a male. This percentage is up from approximately 5 percentage points in the demographics, education, and BMI model. No significant changes occurred to any other of the previous variables.

4. Some College and Higher

Also, for individuals with some college completion or higher, no statistical differentiation occurs in predicting likely attrition based on BMI. Although BMI was not significant in predicting attrition, again, being a female sailor did have a significant effect on predicting the likelihood of attrition. When looking at a female sailor with college or higher completed, this individual is approximately 4 percentage points more likely to attrite than a male with the same education level, which is down from approximately 5 percentage points in previous models. Thereby, showing that once controlling for a sailor who completed some higher education, being a female has less of an influence in predicting attrition; interestingly, when comparing female high school graduates and females with some college completion. As previously mentioned, females with a high school diploma have a greater likelihood of attrition compared to those with some college completion. It may be a result of the motivation to complete higher learning that can translate to greater success in military service and lower rates of attrition as some research suggests (Wenger & Hodari, 2004). No significant changes occurred to any other of the previous variables.

D. CHAPTER SUMMARY

As hypothesized, BMI does have a statistically significant effect on attrition. Holding all other variables constant, as an individual's BMI increases, there is an increase in their likelihood of attrition. It is interesting to note that the education variable shows that all education levels were more likely to attrite than a high school. This can come from the lack of motivation a non-high school graduate may have in completing a full first-term. In contrast, this works the opposite for those with higher education. For those with higher education, they may need more motivation which can cause them to separate from the Navy in search of greater job opportunities. This motivation leads to the second goal of the analysis which is to look at a comparison between those who enlisted prior to and after 9/11. The analysis shows that those who enlisted after 9/11 were less likely to attrite as compared to those who enlisted prior to 9/11. However, the interaction between those individuals and their BMI was not as favorable. The BMI increased for those who enlisted after 9/11 and they were more likely to attrite than those who entered prior to 9/11. This may indicate that even as much as people may want to exercise their patriotism and help defend their country, there are still limiting factors that may make it more difficult for them to achieve their ambitions.

V. SUMMARY, CONCLUSIONS, RECOMMENDATIONS

Previous studies attest to the fact that those who are overweight and obese have a greater chance for difficulties in the workplace including overall work stress, lower cognitive function, loss of work days due to injury, and increasing medical costs for not properly maintaining physical performance. One method to measure these physical standards is to calculate a sailor's body fat percentage, by calculating the height to weight ratio and measuring it on a BMI scale. Research has also shown a positive relationship between BMI and poorer physical and work performance.

A. SUMMARY

A probit estimator calculated the predicted likelihood of enlisted first-term attrition. Navy enlisted personnel who entered the Navy between FY01 to FY09 appear to have a positively and statistically significantly likelihood of attrition as BMI increases after controlling for relevant demographic factors. When controlling for BMI, demographics, and education, BMI is statistically significant in predicting the likelihood of attrition. All race variables remain statistically significant, and overall, those sailors are less likely to attrite than White sailors, which is also the case for subsequent regression models. The other interesting relationship with BMI occurs for those who enlisted after FY01. While each individual year after FY01 has a negative effect on the likelihood of attrition, as BMI increases, a sailor is more likely to attrite from FY02 to FY09.

When controlling for each individual gender, BMI has a greater mean change for females in predicting an increase in likely attrition for every one unit increase in BMI. This result is surprising because previous research suggested that because the physical standard for females is more lenient than for males, their physical standards may not be a significant predictor in likely attrition (Buddin, 1989; Kivimaki et al., 2006).

The relationship between varying levels of education and BMI is of interest too. This thesis finds that BMI only appeared to affect the likelihood of attrition of those with a high school diploma. Moreover, the attrition rates for females increases for those with a high school diploma and even more for those with a GED, and slightly decreases for those with some college completion or higher. Additionally the research finds that those with a high school diploma and married are less likely to attrite than in the previous full regression model. Lastly, for those with no high school diploma, a married sailor has a greater attrition rate than in previous regression models. This finding suggests that while the majority of sailors who enlisted in the sample were high school diploma graduates, other levels of education still influence the effects demographic factors have on predicting attrition.

B. CONCLUSIONS AND RECOMMENDATIONS

The Conclusion answers the three primary and two secondary questions from the Objectives, then offers recommendations for each. The first question refers to BMI at time of accession relating to likelihood of first-term attrition. The second question asks of the relationship detail between BMI and attrition. The third question refers to the possible reasons for a correlation.

1. Do Navy Recruits' BMIs at Time of Entry Correlate to their Likelihood of First-Term Attrition?

As shown in the regression analysis, BMI at time of accession does help in the prediction of the likelihood of attrition. While shaping the DMDC and PRIDE data it was made evident that recruits are initially measured for physical standards prior to accession.

a. Conclusion

Studies have shown that there can be added values and a greater potential of military success for extending the "holding period" where recruits have a greater chance of success (Buddin, 2005). Still there are some sailors who make it to the fleet without meeting the approved physical standards and still have a chance for first-term success, however statistically there is a greater chance of attrition as BMI increases. Recruits who do not meet the minimum standards are often kept in holding where they meet regularly for physical fitness training as well as military training until they can pass physical fitness tests and meet standards. This allows for a greater percentage of recruits at time of entry to be within approved physical standards.

b. Recommendation

In order to better capture what effect BMI has for those in the accession process, BUMED should maintain records from a sailor's initial medical screening, and throughout their medical history to record a recruit's evolution into military entrance. The lack of this information prevents identifying the true impact of programs like DEP in predicting recruit military performance and becomes anecdotal at best.

2. Controlling for Individual Characteristics and Demographic Factors, does BMI at Time of Accession to Service Affect the Likelihood of First-Term Attrition?

When controlling for demographic factors, BMI at time of accession has a positive effect on the likelihood of first-term attrition.

a. Conclusion

On average one unit increase in BMI appears to increase the likelihood of attrition by 0.2 percentage points, which supports the hypothesis that BMI does influence the likelihood of first-term attrition. The maximum BMI for males is 26, and for females, it is 31. The dataset shows that 41 female exceed their prescribed standard in contrast to 98,681 male observations that exceeded their prescribed standard. Since males are characteristically less likely to attrite than females, the current standard set for the Navy may not be in direct correlation with the typical BMI variation of Navy sailors.

b. Recommendation

In light of the fact that there is such a disparity in those who exceed the approved physical standard among males and females, reshaping the limits of acceptable BMI would help align the standards with the type of BMI of recruits joining the Navy. Commander, Navy Recruiting Command (CNRC) and BUMED should increase the standard for males which could decrease the number of waivers that need to be granted upon accession. The alternative would be to enforce the standard in place by not allowing as many waivers to be granted and ensure sailors were qualified prior to accession. MEPCOM should be charged with mandating the overweight sailors to remain in a pre-accession program (e.g., DEP) until individuals can reach and maintain the physical standards.

3. If BMI is Shown to Predict Attrition, What are the Possible Causes?

Possible reasons for an increase in BMI positively predicting likely attrition can come from the background sailors have from different demographics and previous work experience. The typical range of a recruit is between 17–22 years of age, which are very formative years in one’s life. Failure in fully forming and exhibiting new habits can often be a source of problems for those aspiring recruits if this is not promptly and adequately addressed.

a. Conclusion

Sailors are often recruited under the pretense that they will lose the weight quickly and be within the approved Navy standards prior to failing three consecutive BCAs. This approved accession usually comes in the form of a medical waiver that allows for military entrance despite some concerns. Should a recruit fail to meet physical standards, an early separation is warranted pending a medical review board before finishing their first term of service. Another reason might be that young sailors often do not know how demanding and stressful the work may be and are unprepared for the stressors that can come from low control over the food choice or the operational tasks in the work environment (Kivimaki et al., 2006).

Another possible reason for a positive influence BMI has on the likelihood of attrition can be poor sailor readiness management on fitness tests and routine assessments. While programs are in place for sailors to learn about nutrition and healthy means to lose weight, it is not often impressed upon sailors to proactively maintain this lifestyle until they have multiple documented weight problems (Anderson, Quinn, Glanz,

& Ramirez, 2009). Differentiating BMI over a sailor's enlistment is inconclusive in the research, which does not create an accurate picture of the amount of change an individual experiences.

b. Recommendation

CNRC should implement a policy change to examine BMI changes from a recruit's first medical evaluation prior to beginning a pre-accession program. BUMED can then record the BMI immediately prior to an accession medical evaluation. This will help shape the changes to a recruit and point to added benefits and potential increase of pre-accession programs to support reduced attrition.

4. What Are the Navy Enlistment Standards for BMI and have they Changed over Time?

The BMI standards for males and females are at 26 and 31, and have not changed since Buddin (1989) examined the relationship between BMI and attrition. This was a standard set, but does not adequately represent the typical BMI for males and females in the Navy today. The average for males is just around 26, while it is only around 27.5 for females.

a. Conclusion

The data identified a heavily saturated number of overweight males. A possible change could increase the Navy standard for BMI for males to reflect the realistic number of overweight males. As previously mentioned, there has not been a change to the physical standard, but many males fall to the right of the BMI 26 threshold, but are often still allowed to join the Navy. Females have an approved upper limit of 31, but only 41 individuals in the sample exceeded this limit. A regression analysis suggests BMI does have an influence in predicting likelihood of attrition. One way to ensure a reduction in the number of average attritions from roughly one-third is to improve the accession process to give the candidates a better chance of first-term success.

b. Recommendation

As it currently stands, BUMED does not calculate BMI merely using a sailor’s height and weight, as has been measured in this thesis. Rather, BMI is calculated by measuring neck-to shoulder-to waist, which can differ from the height to weight calculation as noted in the Physical Readiness Program Operational Guide, OPNAVINST 6110 series. BUMED should change the policy to shift BCA measurements to an average of different body mass calculations to represent medical health better, while keeping in line with military health standards. It would be comparing WHR, traditional BMI calculation using height/weight measurements, and waist circumference to determine average body mass.

5. Should Enlistment Standards, Occupational Assignment, or Training Policies and Practices be Changed to Accommodate National Trends in BMI among Enlistment-Age Youth?

The basis for including Navy ratings into the regression analysis was to see if ratings as a whole had any bearing on the likelihood of attrition. This is to ascertain if certain ratings represent a particular demographic that shows a difference in BMI based on Navy occupation.

a. Conclusion

The research is inconclusive in determining if sailors of a certain rating occupation are more predisposed to early first-term attrition. While there is currently only one approved Navy-wide physical standard for males and females, there is no account for the multitude of Navy occupations that exists in the Navy. Historically, high-quality recruits make better sailors who thereby have greater chances of success in the first-term. This is attributed to academic aptitude than anything else. If a stellar academic sailor did not meet the physical standards, but could still perform an occupation well, the Navy would likely be able to retain this sailor for at least the completion of a full first term.

b. Recommendation

As mission areas change to fulfil needs of the Navy, CNRC should match physical standards to a sailor's occupation and not a one-size-fits-all guideline for everyone performing different occupations. The only exception would be for those sailors who are expected to conduct Condition I damage control fighting efforts onboard ships. This would limit the number of quality sailors lost, while minimizing training costs and additional costs to recruit and train a new accession.

C. FUTURE RESEARCH

Previous studies have looked at some cognitive factors that being overweight can negatively influence. Studies have also discussed how behavioral factors are related to attrition with the use of survey data and questionnaires among enlisted personnel. Future research should investigate if a similar relationship exists among individuals' self-reported behavior, their BMI and potentially health lifestyle, and the likelihood of attrition. A blend of quantitative and qualitative analysis could be done to identify better if a recruit is actually overweight or has greater than average muscle mass while looking at how they are able to handle demands of the workplace, which can determine a better formula for predicting the likelihood of attrition.

No previous study has looked at the difference in a Navy standard for BMI and those who exceed this standard. Future research can also ascertain if a variation occurs in those who exceed the Navy standard for BMI and their likelihood of attrition. This thesis only looks at how BMI generally affects the likelihood of attrition. Future research can also note if a variation in those who exceed the Navy BMI standard is due to a waiver or if other pre-accession programs are in place that can impact the determination a sailor has in completing the first service obligation. This can help to explore a more finite relationship between height/weight standards and attrition. Broadening the scope of this study to pinpoint specific factors that have a greater influence in female attrition rates would also be beneficial to target ways to decrease attrition rates among females who decide they want to serve.

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APPENDIX. PROBIT REGRESSION FOR FIRST-TERM ATTRITION

Table 9. Probit Regression Results for Navy First-Term Attrition

VARIABLES	(1) Demographics	(2) Demographics Education BMI	(3) Demographics Education BMI Ratings	(4) All Variables BMI*Post_2001 Interaction
age	-0.005***	-0.004***	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)
married	-0.030***	-0.054***	-0.076***	-0.077***
	(0.010)	(0.010)	(0.010)	(0.010)
female	0.130***	0.138***	0.145***	0.145***
	(0.006)	(0.006)	(0.006)	(0.006)
black	-0.006	-0.075***	-0.058***	-0.058***
	(0.006)	(0.006)	(0.006)	(0.006)
native	-0.092***	-0.114***	-0.109***	-0.111***
	(0.018)	(0.018)	(0.018)	(0.018)
asian	-0.347***	-0.378***	-0.358***	-0.357***
	(0.013)	(0.013)	(0.013)	(0.013)
other	0.022**	0.013	0.008	0.009
	(0.010)	(0.010)	(0.010)	(0.010)
hispanic	-0.239***	-0.282***	-0.210***	-0.210***
	(0.007)	(0.007)	(0.007)	(0.007)
non_hs_dip		0.334***	0.323***	0.321***
		(0.010)	(0.010)	(0.010)
ged		0.394***	0.378***	0.376***
		(0.011)	(0.012)	(0.012)
coll		0.071***	0.100***	0.100***
		(0.010)	(0.010)	(0.010)
afqt		-0.006***	-0.007***	-0.007***
		(0.000)	(0.000)	(0.000)
bmi		0.004***	0.005***	-0.002
		(0.001)	(0.001)	(0.002)
Ratings	No	No	Yes	Yes
post2001				-0.244***
				(0.046)
bmipost2001				0.008***

VARIABLES	(1) Demographics	(2) Demographics Education BMI	(3) Demographics Education BMI Ratings	(4) All Variables BMI*Post_2001 Interaction
				(0.002)
Constant	-0.157***	0.028	0.607***	0.777***
	(0.017)	(0.024)	(0.025)	(0.046)
Observations	343,771	343,771	343,771	343,771

Notes: All regressions were estimated via Derivative Probit (Dprobit). Standard errors appear in parentheses.
*** significant at 1%   ** significant at 5%   * significant at 10%

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